RAIN FROM CUMULUS CLOUDS OVER FIRES.

[Extracts from Fourth Meteorological Report of Prof. James P. Espy, 34th Cong., 3d Sess., Senate Ex. Doc. No. 65, 1857, pp. 29-36.]

The observation of cumulus clouds over fires, even over factory chimneys on very damp days, is by no means rare; and so, a general review of all published observations of such clouds does not seem called for. It may be of interest, however, to quote from accounts of cloud developments which were strong enough to precipitate showers.—EDIT.

FALLOW FIRE AND SHOWER AT COWDERSPORT, PA.

[Letter to James P. Espy.]

"COWDERSPORT, PA., *July 29, 1844.*

"* * * On Saturday, the 13th of July [1844], about 1 o'clock, a fallow, containing about 6 acres, was fired. At the time the fire was set the day was calm and warm, and would be considered clear. There were some flying clouds, with slight appearances of rain to the north, but none in the neighborhood. The fire spead rapidly, and burned with great violence. In a short time a white cloud was seen to form over the black smoke which rose from the fire with great velocity, nearly perpendicular. The white cloud rolled outwards above, especially toward the north and south, and probably still more toward the east, as the wind was gentle in that direction, and as the rain which fell from it increased as it proceeded east, as far as heard from. It did not swell out very far to the west. In less than an hour from the commencement of the burning, very large drops of rain were seen by the inhabitants of Cowdersport descending from the cloud, glistening in the sun like diamonds. It rained but little in Cowdersport, which is about 100 rods west of the fire, and none at all one-half a mile west of the village. * * * Mr. Lyman lives 2 miles east of Cowdersport, and he found that the quantity of rain which had fallen constantly increased as he advanced. When he got home he found the ground quite wet. Previous to the rain it was quite dry and parched, suffering much for want of rain. Samuel Taggart lives 6 miles east of Cowdersport, and at his place the shower was very violent, with unusually large drops of rain. The shower at Mr. Taggart's did not last, probably, more than 30 minutes, but it rained an unusual quantity for the time.

"Some of our citizens watched the whole formation of the cloud, and its gradual recession toward east after the rain; and we have understood from credible authority that it rained hard and much longer the same afternoon many miles to the east. We are unanimously of the opinion that *this rain was produced by the burning of the fallow;* and we think it due to your zeal in the cause of science to make this communication to you. * * *

"JOHN S. MANN, *Attorney at Law.*
"CHARLES LYMAN.
"W. C. BUTTERWORTH, *Attorney at Law.*
"SAMUEL TAGGART.
"JOHN B. PRADT, *Episcopal Clergyman.*
"DAVID T. HALL."

"JULY 28, 1844.

"I live about 22 miles east of Cowdersport, and about 2 o'clock on Saturday, the 13th of July, I left home on a beautiful clear day, but I had traveled only about 3 miles when a very heavy shower came on, the drops being uncommonly large, glittering in the sun much of the time. The cloud came up from the west, and had not covered the whole sky when the rain came on; indeed, it did not cover the whole sky at any time, though the rain lasted from half to three-quarters of an hour. This was the first rain we had for a considerable time, and it was very much needed.

"E. JOHNSTON, *Justice of the Peace.*"

"POTTER COUNTY, PA.

"Understanding that you wish to know whether it rained here on Saturday, the 13th of July, 1844, I have to inform you that about 3 o'clock there was a very hard shower about 6 miles east of this place, 28 miles east of Cowdersport, where I was at the time, and I found when I returned home that it had both rained and hailed hard the same afternoon at my house, 22 miles east of Cowdersport. * * *

"FRANCIS L. METZGAR."

PRAIRIE FIRE IN INDIANA.

Dr. W. Hembel Salter, of Pulaski County, Ind., gives me an account of a rain which was produced by the burning [over] of a prairie, 7 or 8 miles northeast of his residence, on the 6th day of August, 1843. He says:

"WINNIMAC, IND., *August 28, 1843.*

"The day had been exceedingly sultry and warm; the thermometer stood at 88°; several clouds were seen floating at the time at a great height, but there was *no appearance of rain.* At 15 minutes before 3 o'clock a gentle breeze sprang up from the southwest, blowing directly toward the fire, which at 3 o'clock had increased to a perfect gale. The dark volumes of smoke and flame at this time had ascended to a great height, when, after reaching an immense height, it was observed, by the direction which the dark mass assumed, that there was a counter current of the atmosphere above, toward the west by southwest. I was now an eyewitness to the formation of the clouds. At first the cloud was insulated; I could see all round it, and I do not believe any other clouds were seen at that time within 50 miles of this place. Nothing could exceed at this time the magnificent appearance of the sky.

"The clouds kept forming until, seemingly unable to support their weight, they rolled over each other until they appeared to have enveloped the whole heavens in gloom, when, falling into the lower current, they were conveyed toward the northeast, where, I think, much rain must have fallen. * * *

"W. HEMBEL SALTER, M. D."

FLORIDA SHOWERS FROM BURNING SAW-GRASS PONDS.

"DEAR SIR: Your request for a relation of my experiments upon your theory of storms is flattering. I answer it with pleasure. They were at first accidental, and afterwards intentional. I will describe both.

"In 1845 I was engaged in the public survey on the Atlantic coast of Florida. Some time in April (the time of the dry season there, which lasts up to June) I was running a township line between latitudes 26° and 27°, about 5 miles from the sea. The weather was oppressively warm that day; there was not air enough stirring to move an aspen leaf. We found our line must pass through a saw-grass pond containing about 500 acres.

In ponds of this description the green grass at the top shoots up from 5 to 6 feet in height, and when the region has not been for some years swept clear by fires, the dead and dry growths of preceding seasons accumulate under the latest growth, and are often found there from 2 to 4 feet in depth. They are exceedingly inflammable. When lighted in dry weather, they burn with frightful rapidity and violence. Whenever, in our explorations, we came upon a place of this description, we could only pass our line by cutting away the lofty fresh grass, and wading (or rather wallowing) through the mud and under rubbish. On the day in question we determined, as it was so hot, that, to save ourselves trouble, we would burn our way through. * * * [After lighting from both sides,] in a very few minutes an awful blaze swept over the entire surface, which we had marked out for our purpose. We then crossed our line. Ere we had proceeded over 40 chains a delightful breeze sprang up and cooled the atmosphere, and presently a refreshing shower sparkled in the bright rays of the sun. All this excited no further observation than that it had not rained before there for a long time. * * *

"Our work went on for some days without a repetition of our short cut at pioneering. * * * At length, however, the pleasant breezes ceased, which had made the weather for a while endurable, and the still air and intense heat returned, and with them constant murmurs from the men, especially the negroes, whose duty it was to cut lines and mark trees. We were now on the confines of a saw-grass pond, and a much more formidable one than any we had yet encountered. Being surrounded by a cypress swamp, we concluded that it had never yet been burned. My assistant, Capt. Alexander Mackay, mentioned his having in our late conflagration observed the formation of a cloud at the apex of the smoke. He added that it had frequently since brought to his mind some account which he had read of Prof. Espy's theory. He suggested that there could not be a better opportunity than this to put the theory to the test, and being fond of a joke, he said he would like to astonish the superstitious negroes, and to make them believe that he could call together the clouds and bring down rain. So we determined to make the experiment.

"When our party were all gathered at the halting place complaints of the extreme heat went round, and all unanimously agreed that a more confined and oppressive day had never been known to them. To these complaints the usual wishes for a 'little breath of air' and a 'few drops of rain' succeeded. 'Cut through this pond,' exclaimed the captain, 'and I'll bring you more than a few drops of rain; I'll give you a plentiful shower, and a breeze, too, that shall wake you up. Come, boys, cut away, and when you've done you shall wash off the dust in a cold bath from the skies!' They stared up and around; not a cloud as large as a man's head was to be seen, and they looked back at the captain with a good-natured grin of incredulity. 'Ho, ho! ha, ha! captain make cloud out o' nuffin; he, he! captain bring water all dis way from de sea! Ho, ho! ha, ha! he, he!' Whereupon the captain affected to be very indignant. To hasten his victory, I ordered the grass to be set on fire. The flames soared forthwith above the tallest trees; a dense volume of smoke mounted upward spirally; the grass soon disappeared; we crossed over. As the smoky column broke and the cloud began to form, the captain traced a large circle in the sand around him, and placed himself in its center, making fantastic figures and forming cabalistic phrases out of broken French; still was the cloud unnoticed. All eyes were riveted upon the captain, who stood gazing at the earth, and shaping outlines of devils there. At this juncture came a roll of distant thunder; every glance instantly turned upward; a cloud was spreading there; the thunders increased; the lightnings flashed more vividly; the knees of the negroes shook together with alarm; already was the rain descending, and in torrents, though the clear sky could be seen in all directions under the cloud. The captain, meanwhile, maintained his mystical attitude, and continued his wild and extraordinary evolutions. Some of the whites who were in the secret of the hoax fell on their knees, and were imitated by the negroes, whose fears augmenting as the storm grew fiercer, with clasped hands fastened upon the captain a stare of awe and deprecation. In short, the scene presented a more complete triumph of philosophy over ignorance than I could have supposed it possible to have produced anywhere in the nineteenth century, and most especially anywhere in our enlightened Republic.

"We often fired the saw-grass marshes afterwards; and whenever there was no wind stirring we were sure to get a shower; and I say with perfect confidence that we never had a shower in April or May at any other time. Sometimes when there was a breeze, it would carry the smoke toward the horizon, where there would seem to be a fall of rain.

"GEORGE MACKAY.

"P. S.—I have lately been informed by A. H. Jones, United States deputy surveyor, that he has performed a great many experiments in Florida of a similar nature, with like success; and that for some years several farmers, who became acquainted with these experiments, have been in the habit of setting fire to the dry grass at the time they plant their corn to produce rain; and that they generally succeed, though (this being in the dry season) it is known that no rain would otherwise occur.—G. M."

FOREST FIRE THAT QUENCHED ITSELF.

"July 14, 1846.

* * * *

"[After an almost complete dry spell of five weeks on Isle Royale, Lake Superior, on the 11th of July, the woods on the island, whether accidentally or by design, took fire.]

"The rocks in this country are covered with a heavy growth of moss, and the trees, which are mostly spruce, Canada balsam, birch, white cedar, and white and yellow pine, are also hung with moss similar to that which is found in the South. It collects upon the underbrush, which is so thick that a man can only with great difficulty make his way through it.

"The fire, during the night of the 11th, spread to a slight degree, but on the 12th the wind rose and the flames raged like a whirlwind, seeming to leap from tree to tree like threads of electric fluid and darting onward as if desirous to consume every living thing. The moss, the branches of the balsam trees, the pitch concealed in the rough bark, and that still more ignitable matter, the outside bark of the birch, all seemed to woo the fiery element to the fullest display of its resistless fury.

"During the burning on the 12th there appeared clouds around and about the fire, which swept away to the east of the fire. In the evening the wind ceased, and all was clear as before, and the fire seemed smoldering as if it were in repose after the destruction of the day. On the morning of the 13th the wind arose with more than usual violence about 10 o'clock. The fire had spread a mile or two to the west, and had become one general conflagration for the area of about 5 miles square, where the

clouds around and about, and to the east of the fire, again made their appearance, while in every other quarter it was clear. Now, said I, to one of the company, 'If Espy's theory is worth anything, we should have a shower of rain.'

"The clouds now began to grow more massive, and repeatedly changed color, giving decided evidence of an approaching storm. In a few moments more the rain began to fall, first in large crystal drops in exact imitation of an evening sunshine shower, and then a heavy dash of rain descended, which wet us to the skin, and continued until the fire was extinguished.

"For weeks before there had not been a cloud to be seen, and at the time the rain was descending there were no clouds to be seen, except on the island in the immediate vicinity of the fire. Every place else was enveloped in clear, bright sunshine. The evidence that the rain was caused by the fire was unmistakable, for with the fire came the clouds, with the clouds, the rain; and when the fire was quenched by the rain, all was again brightness and sunshine.

"ABEL SHAWK."

FALLOW FIRE AND SHOWER IN NEW HAMPSHIRE.

"In July, 1856, I had occasion to cross this ridge [west of Keene, N. H.] and to pause on its summit to give a little rest to jaded animals. The weather was excessively hot. Not a cloud was to be seen, nor was there a breath of wind stirring. Looking to the southeast at a distance of some 5 or 6 miles, I saw a fire just kindled in a fallow of some acres extent. * * * Up went the column straight as an arrow, and anon it began to expand at the top and assume the appearance of cloud. This cloud, with its base stationary, expanded upward, and swelled as if a huge engine was below with its valve open for the escape of steam. The thin white cap appeared; the color changed, and soon the rain began to descend.

"It remained stationary for a few minutes, looming up higher and widening on either side a few minutes, and then sailed off in an eastern direction, pouring down torrents of rain in its pathway. I do not know the exact time occupied in this process, but I do not think more than half an hour elapsed between the kindling of the fire and the time the rain commenced falling. All this time at my point of observation the sun was shining brightly, and, besides that one over the fire, there was no cloud to be seen."

"J. D. WILLIAMSON,
"Pastor of the First Universalist Church.
"OCTOBER 30, 1856."

THUNDERSHOWERS FROM GRASS FIRES IN PARAGUAY.

"M. Dobrezhoffer, in his account of the Abiphones of Paraguay, volume 3, page 150, says: 'I, myself, have seen clouds and lightning produced from the smoke over the tall grass and bulrushes, as it is flying off like a whirlwind; so that the Indians are not to blame for setting fire to the plains in order to produce rain, they having learned that the thicker smoke turns into clouds, which pour forth water.'

"The bad philosophy of supposing that the smoke turned into cloud does not invalidate the evidence here furnished, that rain was produced by the fire." [1]

[1] Naegler (Das Wetter, Aug.-Sept., 1917, p. 179) reports the formation of a great cumulus over a fire on a nearly calm day at Kobilnik, Russia, June 21, 1917. About 4 km. from the fire large raindrops fell for 10 or 15 minutes. He mentions also the common formation of great cumulus clouds over the savanna fires during the dry season in tropical Africa.—EDIT.

VOLCANO RAINS.[2]

"Baron Humboldt gives, as an instance of what he calls the *mysterious* connection between volcanoes and rain, the fact that when a volcano breaks out in South America in the dry season, it turns it, while the volcano is in blast, into a rainy season.

"In his Views of Nature, page 366, speaking of Vesuvius in the last great eruption, he says: 'The long drought which had parched and desolated the fields before the eruption was succeeded toward the termination of the phenomenon by a continued and violent rain, occasioned by the *volcanic* storm which we have just described. A similar phenomenon characterizes the termination of an eruption in all zones of the earth. As the cone of cinders is usually wrapped in clouds at this period, and as the rain is poured forth with more violence near this portion of the volcano, streams of mud are generally observed to descend from the sides in all directions.' "

HEIGHTS OF CUMULUS CLOUDS FORMING OVER FIRES.

By S. P. FERGUSSON and C. F. BROOKS, Meteorologists.

[Dated: Weather Bureau, Washington, D. C., May 3, 1919.]

Apparently, very few measurements have been made of the height or movement of cumulus clouds over fires. The writers know of but six instances of the kind, and since they are of unusual interest to students it seems desirable to present a brief account of the formation and heights of these clouds.

The first example is a measurement made by A. E. Sweetland and S. P. Fergusson of two small cumulus clouds forming over a fire which destroyed the Bay State Iron Works, in South Boston, June 30, 1899.[1] On this date the weather was fair, the sky nearly cloudless in the afternoon, and the surface wind very light and from a westerly direction. The fire began shortly before 8 p. m. and the smoke-cloud was not of unusual size, but rose vertically to a considerable height (800 to 1,000 meters), encountering at this height a northwesterly wind, which swept it nearly horizontally over Boston Harbor. The smoke reached its greatest height about 8:05 p. m. At 8:03 p. m. a small white cloud began to form at the apex of the smoke, which at this time was nearly over Long Island, in the harbor. This cloud increased rapidly in height, assuming the form of a true cumulus, and reached its greatest dimensions at 8:05 p. m. It was about 3° in height and length, the highest or thickest end being toward the north. Between 8:05 and 8:07 p. m. another, smaller cloud formed at the eastern edge of a rift in the smoke considerably lower than the first and about 5° farther north. Mr. Sweetland, at Winthrop, 8 kilometers northeast of the fire, estimated the altitude of the higher cloud to be 15°, while a measurement with nephoscope by Mr. Fergusson at Blue Hill Observatory, 16 kilometers south of the fire, gave 10° as its altitude as seen from the observatory. These measurements show that the higher of the two clouds was at least 2,500 meters, while that of the lower was about 2,000 meters, above sea level.

The smoke began to diminish in quantity at 8:07 p. m. and separated from the clouds, which became flatter and more elongated. At 8:11 they separated from the smoke by a space several degrees wide, and after this time they slowly evaporated.

[1] Described, with sketch, in Science, July 21, 1899. p. 86.
[2] Cf. Hann's Lehrbuch d. Meteorologie, 3d ed., 1915, p. 692.—EDIT.